

Remarks:

In response to the Office Action dated March 30, 2005, applicants have canceled claim 9, amended claims 1-3 and 10 and added new claim 18. The independent claims now presented are 1 and 18; and all other claims presented depend ultimately from claim 1.

Independent claim 1 stands rejected under 35 USC 102(b) as being anticipated by either Culnane et al 5,672,548 or Distefano 6,388,340. Applicants have amended claim 1 and request reconsideration of the claim as amended and withdrawal of the rejection, in view of the following arguments and explanations.

Applicants claim a package that optimizes heat flow from a semiconductor chip by positioning the non-active surface of the semiconductor chip adjacent the case of the product in which the chip is mounted with only a single thermal interface therebetween connecting the chip and case. Several terms of the previous sentence (and claim) need to be explained. First, the term "product case" is used throughout the specification (page 3, line 10; page 2, line 2; page 4, lines 4, 11; etc.) to mean a container for the semiconductor chip and its mounting, including any circuit board or flex circuit to which it is affixed, for shielding it from the outside environment. It does not refer to internal heat sinks and heat spreaders that may be mounted in contact with semiconductor chips within the product case, such as elements 246, 270 and 320 of Culnane et al Figures 4-6 or element 10 of Distefano Figures 3-7. Second, the phrase "thermal interface" is used, as in the industry, to denote a material composition having high heat conductivity that is applied in a comparatively thin layer between to solid objects to efficiently conduct heat from one to the other. A relevant example of such objects is a heat generating object such as a semiconductor chip and a heat radiating object, such as a heat sink or spreader: as shown in Figure 4 of Culnane et al, in which a layer 244 of a heat conducting substance provides a thermal interface between semiconductor chip 248 and heat sink 246. With these explanations in mind, applicants will discuss the amended claim 1 in view of the cited references.

In the entire Culnane et al document, no product case is shown or discussed; in fact, the word "case" does not appear in the document. Thus, there is no specific teaching of the placement of a non-active surface of a semiconductor chip adjacent a case and connected thereto through a single thermal interface in the Culnane et al document. Of course, as the Examiner will surely point out, it may be assumed from normal practice in the industry that the packages shown in Culnane et al would customarily be placed in a product case, but such an assumption does not necessarily anticipate a single thermal interface between such a product case and an adjacent, non-active surface of a semiconductor chip. In fact, Culnane et al teaches against such an arrangement. Every Figure of Culnane et al shows another object, such as a heat spreader or sink, adjacent the non-active side of any semiconductor chip and connected thereto with a thermal interface. These heat spreaders or sinks would necessarily lie between the semiconductor chip and the assumed product case and thus prevent the non-active surface of the semiconductor chip from being "adjacent" the product case. In addition, in order to provide an efficient thermal conduction path between the semiconductor chip and the product case, a second thermal interface would be necessary between and connecting the product case and the intervening heat spreader or sink. This is seen even more clearly in Figure 7, which shows Culnane's teaching of multiple semiconductor chip packages in a computer environment. The entire apparatus shown in Figure 7 would be placed within a product case; and the latter could not possibly be located adjacent the non-active sides of the semiconductor chips or connected thereto by a single thermal interface due to the presence of a blocking heat sink or spreader. Rather, the non-active side of each semiconductor chip is covered by a heat sink or spreader with a first thermal interface therebetween; and the product case would be outside the heat sinks and spreaders. Connecting the heat sinks and spreaders to the product case would require a second thermal interface.

Distefano also does not show, discuss or even use the word "case" anywhere in the document. In addition, Figures 3-7 showing cross-section views of semiconductor chip packages all show heat spreaders adjacent the non-active sides of the chips as in Culnane et al. Figures 1 and 2 do not specifically show such heat spreaders, but that is because the document starts its description with the core arrangement of the semiconductor chip mounting and connection. As soon as the question of heat

dissipation is first raised in the description (column 7, line 52), thermal spreader 10 is introduced and reference is made to Figure 3. In other words, Distefano teaches the use of thermal spreader 10 to dissipate heat from the semiconductor packages of Figures 1 and 2; and Figure 3 is an example of what should be done. Thus, Distefano also teaches away from placing the non-active surface of a semiconductor chip adjacent a case with a single thermal interface therebetween.

Johnson similarly teaches away from the claimed invention by placing a “thermally conductive planar member” 22 adjacent the non-active surface 18 of semiconductor chip 12, with thermal interface 26 therebetween, and thus requiring a second thermal interface between member 22 and the product case. Member 22 is definitively not a product case because it does not contain anything (and in fact is itself contained, except for its upper surface, within the dielectric thermoset plastic 26 that is injected around a good portion of the semiconductor chip. This sort of arrangement appears to be common in the prior art on the chip/circuit board level and is not what applicants claim, as shown in their own Figure 1 prior art embodiment in this application. Wu et al, Lo et al, etc. show similar arrangements, with similar teachings. As an aside, the word “case” appears in Lo et al, Gore et al and Swigget et al – but only in the sense of “example” (not in the sense of “container”).

Applicants thus maintain that no prior art reference cited or of which they are otherwise aware shows the claimed combination of a power device package including at least one semiconductor chip having an active side and a non-active side, wherein the power device package is disposed in a product case and the non-active side of the semiconductor chip includes a heat sinkable surface positioned adjacent to the product case with only a single thermal interface therebetween. This claim is supported by the description, which consistently uses the phrase “product case,” and the drawings (Figure 11) as product case C. The description and drawings also show that it is the heat sinkable surface of the non-active side of a “semiconductor chip” that, as claimed, is adjacent the product case. Although, for convenience, only a portion of case C is shown in Figure 11, the use of the phrase “product case” and the complete description makes clear that it actually surrounds and contains the rest of the apparatus shown in the Figure.

The rejection of claim 1 and its dependent claims under 35 USC 102(b) should therefore be withdrawn. In addition, since the cited references, along with common industry practice, actually teach away from the claimed invention by placing another heat sinkable object, such as a heat sink or spreader, between the semiconductor chip and any possible product case, no rejection under 35 USC 103(a) could be legitimately supported by the cited prior art.

Newly presented claim 18 adds to the elements of claim 3 (and its parent claim 1) an additional semiconductor chip of significantly different thickness between its active and non-active sides, with the heat sinkable surfaces of the non-active sides of the chips being substantially co-planar (that is, substantially the same distance from the case) and those of the active sides being in different planes (that is, at different distances from the case), as allowed by the flexible circuit to which they are both coupled. This is also not shown in any of the cited references.

Thus, applicants request the allowance of all claims now presented.

Respectfully submitted,



Robert M. Sigler
Attorney - Reg. No. 26,505
(248) 813-1245

RMS